

evidently with the cobalt salts many, and it may be the most important, bands lie in the ultra-red. All the above spectra and many more have been drawn from direct and repeated observations, but obviously it is not intended to claim any originality for them; many have been described before.

My best thanks are due to my assistant, Mr. W. Lapraik, for the help he has given me in carrying out these investigations, which have extended over a considerable length of time.

“On the Female Organs and Placentation of the Raccoon (*Procyon lotor*).” By M. WATSON, M.D., Professor of Anatomy, Owens College, Manchester. Communicated by Professor HUXLEY, Sec. R.S. Received December 30, 1880. Read January 20, 1881.

[PLATES 3—6.]

Of late years our knowledge concerning the form and structure of the placenta, as well as of the arrangement of the foetal membranes in various species of mammals has been much extended through the researches of Milne-Edwards, Ercolani, Turner, and others. The observations of these anatomists have not been confined to the placentation of any one group, but extend to that of species belonging to every Mammalian order. Among these orders that of the Carnivora has received a not inconsiderable share of attention, not only from the observers just named, but also from those among whom may be mentioned the names of Daubenton, Von Baer, Bischoff, and others who appeared earlier in the field. Among the members of the fissiped group of Carnivora, the placenta or foetal membranes, or both, have been described in the marten (*Martes domestica*),* stone marten (*Mustela foina*),† pine marten (*Mustela martes*),‡ weasel (*Mustela vulgaris*),§ ferret (*Mustela furo*),|| bitch (*Canis familiaris*),¶ fox (*Canis vulpes*),** cat (*Felis domestica*),†† lioness (*Felis leo*),‡‡ hyæna (*sp. ?*),§§ and otter (*Lutra vulgaris*),||| whilst among the

* Buffon's "Histoire Naturelle," vol. vii, p. 81, Pl. XX.

† Bischoff, "Sitzungsber. Akad. Wissensch.," München, May 13, 1865.

‡ *Idem*, p. 343.

§ *Idem*, p. 343.

|| Buffon's "Histoire Naturelle," vol. vii, p. 105, Pl. XXVII.

¶ Bischoff, "Entwickelungs-geschichte des Hunde-Eies." Von Baer, "Entwickelungs-geschichte der Thiere," 2ter Theil, p. 238.

** Turner, "Trans. Roy. Soc. Edin.," vol. xxvii, p. 297.

†† Turner, "Lectures on the Comparative Anatomy of the Placenta," p. 72.

‡‡ Owen, "Anatomy of Vertebrates," vol. iii, p. 744.

§§ *Ibid.*, p. 744.

||| Bischoff, "Sitzungsber. Akad. Wissensch.," München, March 4, 1865, p. 213.

pinnipeds we find that the placentation has been examined in *Phoca vitulina*,* *Phoca bicolor*,† *Halichærus gryphus*,‡ as well as in two seals, the species of which were not determined.§

It will be observed that in this list, which, so far as I can ascertain, contains the names of all the carnivorous mammals the placentation of which has been investigated, that of the racoon (*Procyon lotor*) does not occur. This is the more remarkable, inasmuch as the racoon is one of the mammals which most frequently finds a place in our collections, and one which apparently thrives well under artificial conditions of existence. At the same time, as occurs so frequently in the case of wild animals kept in a state of captivity, the generative functions of the racoon appear almost constantly to remain in abeyance. Mr. Bartlett, the skilful superintendent of the menagerie of the Zoological Society of London, however, in answer to enquiries, informs me that the racoon has occasionally bred in confinement, but only after the mother had been in the gardens for several years. He adds, moreover, that neither the length of the period of gestation nor the condition of the young at birth are known to him. In view of the total lack of definite knowledge concerning the anatomy of the female organs of *Procyon* in the pregnant state, I consider myself extremely fortunate in being able, owing to the kindness of the Messrs. Jennison, proprietors of the Bellevue Zoological Gardens of this city, to give some account of these organs as they occurred in an individual which, in their gardens, had reached an advanced stage of pregnancy.

I shall, in the first place, describe the female organs, and thereafter proceed to the consideration of the anatomy of the placenta.

On opening the abdominal cavity, the distended condition of the right cornu uteri showed at once that the animal was pregnant.

Ovary.—The ovary, rounded in form and somewhat flattened from above downwards, measures one-fourth of an inch in diameter. Its surface presents a somewhat lobulated appearance, which, however, is not due to the presence of corpora lutea, not a trace of these being distinguishable in the organ of either side. The ovary is situated in close proximity to the free extremity of the uterine horn, and is retained in position by means of two ligaments. Of these, one, to be more particularly described presently, attaches it to the posterior surface of the diaphragm, whilst the other passes from the inner end of the ovary to the free extremity of the corresponding uterine horn. The Fallopian tube, moreover, almost encircles it and serves to retain it in close relation to the uterus. The ovary is altogether destitute of any

* Barkow, "Zootomische Bemerkungen," Breslau, 1851.

† Alessandrini, "Meckel's Deutsch. Archiv für Physiologie," vol. v, p. 604.

‡ Turner, "Trans. Roy. Soc. Edin.," vol. xxvii, p. 275.

§ Rosenthal, "Nova Acta Acad. Cæs. Leo. Car.," vol. xv, 1825.

peritoneal pouch or pavilion, such as in many animals, *e.g.*, hyæna, forms an almost complete sac for the accommodation of this organ.

Fallopian Tube.—This tube describes a very peculiar course. Its abdominal opening, or morsus diaboli, lies in relation to the dorsal surface of the ovary, and is placed between the inner end of the latter and the free extremity of the uterine horn. The opening itself is directed upwards toward the spine of the animal, and appears, at first sight, to be altogether destitute of fimbriæ. Upon closer examination, however, with the aid of a magnifying glass, a number of very minute fimbriæ are seen to surround the aperture. These fimbriæ do not project beyond the margins of the opening, but are concealed within the orifice, and consequently can be of no service at the time of ovulation in grasping the ovary and bringing the latter into direct relation with the Fallopian tube. From the morsus diaboli the tube winds forward so as to reach the anterior margin of the ovary along which it passes as far as the outer extremity of the latter. Here it changes its course, and becoming applied to the posterior border of the ovary, extends along it and terminates abruptly in the much wider extremity of the uterine horn. The Fallopian tube thus almost encircles the ovary. The tube measures three-fourths of an inch in length and one-eighth of an inch in diameter. It is of uniform diameter throughout and presents no trace of a dilated extremity or so-called infundibulum.

Exterior of Uterus, Vagina, and Urogenital Canal.—The uterus consists of a central body and two horns. The left or unimpregnated horn was flattened from above downwards, and was strongly curved, the convexity of the curve being directed forwards. Measured from the middle line of the uterus, its anterior or convex border amounted to $1\frac{3}{4}$ inches in length, whilst its breadth, which was almost uniform, amounted to half an inch. Its free extremity was rounded and into it the Fallopian tube opened abruptly. The right or impregnated horn measured $5\frac{1}{4}$ inches along its convex margin, whilst its posterior, or attached margin, equalled that of the horn of the opposite side. It will be observed, therefore, that after impregnation the alteration in size of the uterus takes place in respect of the anterior or free margin of the impregnated horn, the posterior or attached border of the latter remaining of the same dimensions as that of the opposite side.

The impregnated horn measured 2 inches in greatest breadth and presented a somewhat globular form. Subsequent to injection of the uterine artery with carmine, numerous extremely tortuous vessels could be readily distinguished through its peritoneal investment. These vessels, which, upon opening the uterus, were seen for the most part to correspond to the place of attachment of the placenta, were mostly directed transversely to the long axis of the horn, and extended

from the attached to the free border of the latter. They anastomosed freely with one another and formed a wide arterial meshwork on both the upper and lower surfaces of the horn. It was, however, observed that none of the vessels of the one surface extended over the anterior border of the uterus so as to come into relation with those of the other surface, and that, consequently, no anastomosis could be distinguished between them. It is probable, however, that the failure to trace any distinct anastomosis between the vessels of the two surfaces of the impregnated horn ought to be attributed to the incomplete nature of the injection, as it appears unlikely, in view of the continuity of the placental substance between these surfaces, that any break in the continuity of the vessels of opposite sides really existed. The vessels in question were visible over the entire surface of the impregnated horn, but were much more thickly distributed in its middle third, which corresponds to the placental zone.

The corpus uteri is not differentiated externally from the vagina, the two organs forming a continuous tube. The position of the os uteri, however, is clearly defined in the interior of the organ by a well-marked valvular fold, to be afterwards described. Taking into consideration the position of this fold, the body of the uterus measures $2\frac{1}{2}$ inches in length and half an inch in breadth. It is flattened from above downwards, and is attached to the walls of the pelvis by means of the broad ligament. This ligament is formed in the usual manner of a double fold of peritoneal membrane, which, after covering the whole of the upper surface of the uterus, and even the anterior portion of the corresponding surface of the vagina, is reflected upon the rectum. The lower surface of the uterus is not invested to the same extent by peritoneum, that membrane being reflected upon the bladder before reaching the os uteri. The uterus, moreover, is retained in position by two additional ligaments, the diaphragmatic and the round. The former consists of a stout bundle of involuntary muscular fibres, which, passing backwards from the diaphragm to free extremity of the corresponding uterine horn, extends inwards parallel to the posterior border of the latter and is inserted into the body of the uterus. The ovary is fixed to the lower surface of this ligament, close to the free extremity of the uterine horn. The *round ligament* is also well developed. It is attached by one extremity close to the free end of the cornu uteri, and passes backwards to the inguinal region, where it terminates in the usual manner.

The vagina, from the os uteri to its junction with the urethra, measures $1\frac{1}{2}$ inches in length. *Externally* it is not differentiated from either the corpus uteri or the urogenital canal. The latter measures 2 inches in length. Its external orifice is bounded by two laterally placed folds, or labia, which together constitute a conical eminence

measuring half an inch in height, upon the summit of which the external genital orifice is situated.

Bladder and Urethra.—The parts having been immersed for some time in spirit, the bladder was to a certain extent contracted. It measured when distended $1\frac{1}{2}$ inches in length and was of a regularly oval form. The muscular coat was extremely thick, the separate bundles of muscular fibres being clearly defined beneath the peritoneal investment. The latter covered the whole of the upper surface of the viscus as far back as the entrance of the ureters, as well as the upper portion of its lateral surface. The lower surface of the apex of the bladder was also covered by peritoneum, whence that membrane was reflected to the anterior abdominal wall. The ureters entered the bladder half an inch from the neck, whilst the urethra passed off from the posterior extremity of the organ. The urethra measured $1\frac{1}{4}$ inches in length. It passed backwards, lying in the substance of the lower vaginal wall, and opened into the commencement of the urogenital canal in the usual manner.

Interior of Uterus, Vagina, and Urogenital Canal.—On slitting open the left or unimpregnated horn of the uterus, a well-defined septum uteri was seen to separate the right and left horns. It measured three-quarters of an inch in length, and extended backwards from the anterior or free margin of the corpus uteri. It was attached to the uterine walls in front, above, and below, whilst posteriorly it presented a free, concave, sickle-shaped margin which projected into the cavity of the uterus.

The muscular walls of the unimpregnated horn were of great thickness, and its mucous membrane, which was of a dense leathery consistence, was thrown into numerous thick fleshy folds arranged parallel to one another and at right angles with the long axis of the horn. These folds were present throughout the horn, with the exception of a space of half an inch in length next the septum uteri, at which place the mucous membrane was perfectly smooth and devoid of rugæ. On the left side of the septum uteri there was a single longitudinal fold of mucous membrane which extended from the attached to the free margin of the latter. There was no trace of fluid in this horn. The *transverse* arrangement of the mucous folds in the uterine horn of the racoon seems to be somewhat uncommon, these folds in the majority of mammals being longitudinal and not transverse in direction. According to Cuvier, however, a similar transverse arrangement of the mucous rugæ is met with in the uterus of the civet cat.*

On opening the right or impregnated horn its walls were observed to be much thinner than those of the opposite side. This diminution

* "Leçons," vol. v, p. 149.

in thickness involved both the muscular and mucous coats, and is doubtless to be attributed to mechanical distention of the horn by the contained ovum. The mucous membrane presented no trace of the well-defined transverse rugæ met with in the horn of the other side, and was of a softer and more succulent texture. On careful examination, however, this membrane was seen to be thrown into numerous very minute tortuous and anastomosing folds, which closely resembled those described and figured by Professor Turner in the impregnated uterus of *Orca gladiator*.* These folds were more distinctly marked at the placental site than in other parts of the horn, where the mucous membrane was almost smooth. The more minute description of the microscopic structure of the uterine mucous membrane, together with the modifications which it undergoes in the impregnated horn, will be deferred till after the consideration of the ovum and placenta.

Although the corpus uteri is not distinguishable externally from the vagina, yet upon examining the interior of the cavity the position of the os uteri is seen to be clearly defined by a well-marked valve-like projection of the mucous membrane. This valve consists of two segments, an anterior and a posterior, which, however, are continuous with one another, so that the entire structure presents an annular character. The central portion of each segment of the valve measures half an inch in breadth, whilst laterally, where it becomes continuous with its fellow, each segment diminishes to quarter of an inch in breadth. The two segments together form a circular valve attached to the entire circumference of the uterus, and prolonged superiorly and inferiorly into two points which project backwards into the lumen of the vagina. The mucous membrane of the body of the uterus is thrown into slight longitudinal rugæ, which commence opposite the free margin of the septum uteri, and extend along the whole length of the organ.

The diameter of the vagina, as already mentioned, is the same as that of the corpus uteri; and although, therefore, there is no distinct line of demarcation between these two portions of the genital apparatus visible externally, an examination of the interior of the organ shows that the limits of both are clearly enough defined. In fact, the separation of the corpus uteri from the vagina is indicated by the annular valve above described as corresponding in position to the os uteri; whilst, posteriorly, the vagina is distinguished from the urogenital canal by the position of the urethral orifice, as well as by a slight fringe-like fold of mucous membrane, which is attached to the entire circumference of the vaginal canal. The mucous membrane of the latter is thrown into slightly marked longitudinal rugæ which, however, are of larger size than those met with in the body of the uterus.

* "Lectures on the Comparative Anatomy of the Placenta," p. 45.

The calibre of the urogenital canal equals that of the vagina, the separation of the two organs being marked by the orifice of the urethra and by the fringe-like fold of mucous membrane just described. The mucous membrane of the urogenital canal does not differ in character from that of the vagina.

Having now described the female organs, I pass to the consideration of the

Ovum.

On opening the gravid uterine horn by means of an incision carried along its anterior or convex margin, a single foetus was observed to occupy the greater part of the cavity. The foetus itself, covered only by an epitrichial membrane, was at once in part exposed, from which it was evident that before coming into my hands the foetal membranes had been ruptured. These membranes, although ruptured, where they lay in contact with the posterior extremity of the foetus so that the latter was in contact with the wall of the uterus, retained their relation with the anterior moiety of the embryo; and I was thus enabled to make out the arrangement of both the chorion and allantois. With regard to that of the amnion there still remains some doubt, but to that I shall refer presently. The foetus, curled upon itself, lay with its head directed towards the free extremity of the uterine horn, and close to the opening of the Fallopian tube, being separated from the latter merely by the intervention of the foetal membranes which covered it. The left anterior extremity was closely applied to the side of the chest, whilst that of the right side was strongly flexed at the elbow-joint, so that the palmar surface of the hand rested against the side of the head. The posterior extremity of the foetus touched the septum uteri, and the hind legs, fully extended, stretched backwards towards the body of the organ. The tail, strongly flexed, occupied the interval between the hind legs. The dorsal surface of the foetus was accurately adapted to the anterior or convex surface of the uterine horn, whilst the ventral surface was directed backwards towards the posterior or concave margin of the latter.

The position of the foetus of *Procyon in utero* appears to be somewhat unusual. In the majority of mammals, according to Milne-Edwards,* the head of the foetus usually presents at the os uteri;† whilst in *Procyon* the posterior extremity of the embryo occupied that position.

The foetus was encircled by an annular or zonary placenta which corresponded to the middle third of the uterine horn, and measured

* "Leçons sur la Physiologie," vol. ix, p. 591.

† Turner describes the foetus as occupying this position *in utero* in the seal, "Trans. Roy. Soc. Edin.," vol. xxvii, p. 278; sloth, *ibid.*, p. 75; and lemur, "Phil. Trans.," vol. 166, p. 574.

one and a quarter inches in greatest breadth where it lay in contact with the dorsal surface of the fœtus, while opposite the belly of the latter the placenta did not exceed half an inch in breadth. The placenta had been detached from the uterus, a circumstance which I cannot sufficiently regret, as I was thereby prevented from observing by means of injection the exact relation which existed between the maternal and foetal portions of the placenta. Although detached from the uterine wall, it was evident that no change had taken place in the position of the placenta with reference to either the uterus or fœtus, and consequently the somewhat exceptional position of the latter *in utero* can in no way be attributed to this circumstance. The placenta formed a complete ring, but at the centre of its widest part, *i.e.*, opposite the back of the fœtus, there was a spot similar to that figured by Daubenton* in the placenta of *Martes domestica*, and described by Bischoff in that of *Lutra vulgaris*,† *Mustela foina* and *Mustela martes*,‡ where the substance of the placenta was deficient. This deficiency involved the entire thickness of the placenta, so that a probe could be passed from the uterine to the chorionic surface of the organ without injury to its substance. The absence of placental substance at this spot is of much interest in view of the observations of Bischoff upon the corresponding arrangement in *Lutra*, to which I shall afterwards refer. To the foetal surface of this portion of the placenta the amnion was closely adherent. The entire uterine surface of the placenta, with the exception of a band along either margin, which measured one-eighth of an inch in breadth, presented a very regularly papillated appearance. The marginal bands were perfectly smooth and of a lighter colour than the rest of the organ. Subsequent examination showed that this smoothness was due to the presence of a layer of decidua (reflexa) which concealed the subjacent papillæ.

Chorion.—I have already remarked that the foetal membranes had been ruptured where they lay in contact with the posterior extremity of the embryo. In consequence of this I experienced some difficulty in the determination of their exact arrangement. With the view of completing this with greater exactitude, I removed the entire ovum from the uterus, and having carefully extracted the fœtus by dividing the umbilical cord, as well as the narrowest part of the placenta, I placed the latter, together with the foetal membranes, in a vessel containing spirit. By floating out the membranes in this way I obtained the view represented in fig. 2. From this drawing it will be observed that a membrane which is continuous with each margin of the placenta is prolonged outwards from the latter, so as to form a barrel-shaped envelope in the interior of which the fœtus was contained. This

* Buffon's "Histoire Naturelle," vol. vii, Pl. XX.

† "Sitzungsber. Akad. Wissensch," München, 11 März, 1865.

‡ *Ibid.*, 13 Mai, 1865.

membrane, which was undoubtedly the chorion, agrees with that described in the dog, cat, and other Carnivora, not only as regards its form, but in the fact that a few blood-vessels were prolonged outwards from its villous or placental portion to ramify in its non-placental area. Judging from the extent to which the uninjured pole of the chorion, which accommodated the anterior portion of the fœtus, was prolonged outwards from the placental margin, it did not appear probable that any portion of what (with reference to the fœtus) may be termed the posterior pole of that membrane, had extended into the non-impregnated horn of the uterus. This point, however, in view of the lacerated state of the membranes, it was manifestly impossible to decide in the absence of another and more perfect specimen. At the same time it is to be observed that the limitation of the chorionic membrane to the impregnated uterine horn in the various species of Carnivora previously examined, justifies the conclusion that in *Procyon* that membrane does not extend into the unimpregnated horn, as happens in the case of the Ruminants, Solipeds, and others.

Allantois.—With regard to the exact arrangement of this membrane, owing to the rupture which had taken place, I am by no means certain. At the same time I may state that, by means of careful dissection, I was able to detect a delicate membrane, which, although closely applied to the fœtal surface of chorion, could be readily detached from the non-placental area of the latter. This membrane, which I regard as the allantois, was coextensive with, and formed a lining to the uninjured pole of the chorion. At the margin of the placenta, the allantois could be traced onwards as a distinct membrane, which closely invested the fœtal surface of that organ. Moreover, an examination of the shreds of the posterior chorionic pole showed that here also the allantois could be detached in a fragmental form from the fœtal surface of the former. I feel justified, therefore, in assuming that, had the chorion been entire, the allantois would have been found to be coextensive with and to have borne the same relation to it that it bears in other Carnivora. I failed, however, to detect any prolongation of the allantoic sac along the umbilical cord, nor did I succeed in isolating as a distinct membrane that portion of the allantois which invests the outer surface of the amnion.

Umbilical Vesicle.—Of this structure I could not distinguish the slightest trace. Its absence in *Procyon* is remarkable in view of its constant occurrence in other carnivorous mammals.

Amnion.—After removal of the fœtus from the bag of the chorion, a third membrane was exposed, the interpretation of which occasioned considerable difficulty because of its peculiar relations to the other membranes already described. The appearance of the membrane is faithfully reproduced in fig. 2. The sac in question, when floated out in spirit, presented an appearance not at all unlike the finger of a glove.

Its one extremity was closed, and was attached to the central point of placenta, immediately over the dorsal surface of the embryo. It will be recollected that at this point the placental substance was deficient, and to the margin of this deficiency the blind end of the sac in question was closely adherent. The cæcal extremity, however, did not project through the aperture in the placenta, and consequently did not reach the uterine surface of the latter. A careful examination of the blind end of this sac showed that its outer surface was clearly continuous with that portion of the allantoic membrane which lined the foetal surface of the placenta. Hence we conclude that in *Procyon*, as in other Carnivora, the reflection of the allantois from the inner surface of the chorion to the outer surface of the amnion takes place originally at the central point of the placenta, that is, from the margins of the placental gap; and that along with the amnion, although not separable as a distinct structure, there is combined the inner or reflected layer of the allantois. The other end of the sac was ruptured, and, extending backwards (with reference to the embryo), was compressed between the dorsal surface of the latter and the inner surface of the caudal pole of the chorion. When distended with spirit this sac proved to be of such a size that I had no difficulty in replacing the foetus in its interior. Although from the ruptured condition and its abnormal position with reference to the embryo, the resemblance of this sac to that of the amnion was much obscured, I have little doubt that it must be regarded as representing the latter. In favour of this view is the fact that, unless it be so regarded, there was no other structure the arrangement of which was in any way comparable to that of the amnion; and conversely if it were not the amnion, and inasmuch as its relations negatived the supposition that it could be the umbilical vesicle, we should be compelled to assume that, in *Procyon*, we have a foetal membrane of which there is no representative in any other Carnivore, the placentation of which has been hitherto described. Moreover, the close attachment of the blind extremity of this sac to the margins of the central deficiency of the placenta lends additional support to this view. Bischoff,* in his account of the placentation of the otter, refers to a corresponding deficiency in the placenta of that animal. A similar observation is recorded by him in respect of the placenta of *Mustela foina* and *Mustela martes*.† The presence of this gap in the placental substance he explains by supposing that the separation of the false from the true amnion takes place in these animals at a relatively later date than in the majority of mammals; and that, consequently, an obstruction is thereby occasioned to the investiture, by the vascular allantois, of the foetal surface of the chorion, resulting in the deficiency in question. In accordance with this view, the placental gap must

* "Sitzungsber. der Akad. der Wissensch.," München, 4 März, 1865.

† *Ibid.*, 13 Mai, 1865.

of course correspond to the central point of the placenta, inasmuch as at this point the separation of the true from the false amnion takes place. The close attachment of the true amnion to this point, as well as the fact that the continuity of the allantois over the junction of what originally was the false with the true amnion, could be clearly traced in *Procyon*, lends additional support to this view; while, at the same time, it strengthens the interpretation above given of the morphological significance of the sac in question.

The Fœtus.

Upon removing the fœtus from the uterus, the former was seen to be completely invested by an opaque membrane of a bluish colour. This membrane, to which the name of epitrichium has been given by Welcker,* formed, as it were, a second or supernumerary cuticle to the fœtus, and was closely applied to every part of it. Over the greater part of the fœtus it lay superficial to and concealed the hair with which the embryo was covered. At some places, however, and more especially over the inter-scapular region, the forehead, and the outer sides of the thighs, the free extremities of the subjacent hairs projected through this membrane, as did also the large vibrissæ surrounding the mouth. The membrane was thinner and more closely adherent to the head, the distal half of the tail, and to the legs below the knee and elbow joints, than elsewhere, and could not be removed from these parts without tearing; whereas, from the other parts of the body, where the membrane was of greater thickness, it could readily be detached as an entire structure. The membrane agreed in all respects with the epitrichium described by Professor Turner in the two-toed sloth (*Cholepus Hoffmanni*),† except that in the latter, with the exception of the tactile vibrissæ of the snout, none of the hairs protruded through this membrane; whereas in *Procyon* numbers of the hairs of other parts of the body pierced it. As in *Cholepus Hoffmanni*, so in *Procyon*, the epitrichium was continuous with the mucous membrane of the ears, eyes, mouth, and anus. An examination of the deeper surface of the membrane disclosed a punctated and irregular appearance of the latter. This was doubtless due to the impact of the growing hairs. A similar appearance was met with by Professor Turner in the deeper surface of the epitrichium of the sloth. Under the action of caustic soda, the membrane resolved itself into numerous flattened epithelial scales, in which at times distinct nuclei were visible. These scales differed from those described by Professor Turner in the sloth,‡ inasmuch as their edges were uniformly smooth, and presented no trace of the interlocking processes described by that anatomist.

* "Abhandlungen der Naturforsch. Gesellschaft," Halle, Band x, p. 20.

† "Trans. Roy. Soc. Edin.," vol. xxvii, p. 71.

‡ *Ibid.*, p. 71.

A supernumerary epidermic covering or epitrichium is not confined to *Procyon*. A similar epidermic covering has been described by Welcker as investing the fœtus of *Bradypus*, *Uholæpus*, *Myrmecophaga*, *Dicotyles*, *Sus*, and *Equus*, and more recently Professor Turner has noted its occurrence in the fœtus of *Cholæpus Hoffmanni*. Welcker states that he found no trace of this membrane in the fœtus of *Felis* or *Ursus*. Its total absence in the latter, and its presence in a well-developed form in *Procyon* is remarkable, seeing that, in respect of so many important structural details, these two genera approach one another so closely. Further observations are necessary with regard to the distribution of this membrane among the members of the Carnivora, and when made will in all probability establish its existence in other genera than *Procyon*, in which alone it has hitherto been described.*

The fœtus, measured along the curve of the back from the tip of the nose to the root of the tail, was $4\frac{1}{2}$ inches in length, whilst a straight line from the most projecting part of the forehead to the root of the tail measured $2\frac{1}{2}$ inches. The dorsal region and sides of the body were covered with short hairs of a lead-blue colour, while on the forehead, lower surface of the neck, and outer sides of the thighs, the hair was of a lighter colour. On the ventral surface of the body and inner sides of the thighs the hair was not developed to the same extent as elsewhere. The nails were pure white and fully formed. The eyes were completely closed; and, looking at the comparatively mature condition of the fœtus, I am inclined to believe that, in the case of the racoon, as in that of some other Carnivora, the young are born blind. The umbilicus was situated three-fourths of an inch in front of the anus.

An umbilical cord, as such, could hardly be said to exist. The vessels composing it, after escaping from the belly of the embryo, almost at once separated, and applying themselves to the narrowest part of the placenta, extended forwards towards the back of the embryo, and, after giving off numerous arborescent branches, disappeared by dipping into the substance of the organ.

The vessels composing the cord consisted of two umbilical arteries and a single umbilical vein.

Microscopic Anatomy of the Placenta.

After the placenta had been removed from the uterus, its uterine surface was observed to present an appearance totally different from that which characterises the corresponding surface of that organ in either the bitch or cat, both of which I have myself examined, or

* For full details respecting the nature and distribution of the epitrichium the reader is referred to the papers already quoted of Welcker and Turner.

indeed of that of any other carnivorous mammal whose placenta has been hitherto described. To the naked eye this surface presented merely a flocculent appearance, but when examined with the aid of a simple lens, or, still better, with the lower powers of the compound microscope (Ross, oc. A, object. 3-inch), this flocculent appearance resolved itself into a vast number of clearly-defined papillæ, which covered the entire uterine surface of the organ. The appearance presented under the microscope is faithfully reproduced in fig. 9. I have said that the papillæ covered the entire surface of the placenta; but, along each border of the organ, there was a narrow band, slightly raised above the level of the surface, where the papillæ in question at first sight appeared to be absent. Further examination, however, proved that the papillæ were present here as elsewhere, but that their presence was concealed by a superjacent layer of delicate tissue, which proved to be of the same structure as the uterine mucous membrane. This layer must therefore be regarded as representing the decidua reflexa. The papillæ, under the microscope, presented an appearance closely resembling that of the villi of the small intestine after a successful injection with opaque material, but were of considerably larger size. The papillæ were mostly club-shaped, the apex of each being of greater diameter than the base. Their summits were for the most part uniformly rounded, but here and there a papilla could be distinguished which presented a central depression on its free extremity. The separate papillæ were uniformly simple, and in no one instance did I observe secondary papillæ growing out from a primary stalk. I have observed that the separate papillæ resembled the intestinal villi, but the surface of the placenta, as a whole, presented a widely different appearance from that of the intestinal mucous membrane. This was due to the fact that each papilla was surrounded by a wall of placental substance, which, as it were, enclosed a space, in the centre of which the papilla was situated, and was thereby completely isolated from its neighbours. These walls were quite continuous all over the surface of the placenta. They were not so high as the papillæ which they surrounded; and, consequently, when the placental surface was viewed obliquely, the walls were hidden at places by the papillæ, and appeared to be absent. More thorough examination, however, disclosed their presence over the entire surface of the placenta. The spaces bounded by these walls varied in form. In some places they were square, at others five or six-sided, whilst occasionally they were circular. Looking at the placental surface as a whole, its appearance was not unlike that of a honeycomb filled with grubs, the walls corresponding to the partitions between the cells, whilst the papillæ very fairly represented the contained grubs.

Towards the margins of the placenta the arrangement just described undergoes some alteration. In the neighbourhood of the band of

decidua reflexa, the ridges became irregular, and were no longer distinguishable as continuous structures, but became broken up into more or less elongated portions, the free margins of which were provided with papilliform eminences. This gradual dismemberment of the continuous ridges could be clearly traced in passing from the centre towards the margins of the placenta, inasmuch as the ridges which were clearly continuous and regularly arranged, as above described, at one part of the placenta, became less and less regular and more tortuous at another part. The structure of these ridges, both at the central and at the lateral margins of the placenta, is the same, and differs widely from that of the papillæ, which they enclose. The papillæ I regard as belonging to the foetal portion of the placenta, whilst the maternal portion is constituted by the ridges just described. Underneath the marginal band of decidua reflexa, the foetal papillæ were of smaller size than elsewhere, and were arranged in transverse tortuous rows, which corresponded in breadth to that of the decidual band.

The foetal surface of the placenta, upon removal of the allantois, was seen to be divided into numerous minute polygonal areas which doubtless represent the so-called cotyledons described in the placenta of other Carnivora.

The placenta of the racoon presents no trace of the greenish coloration met with in the margins of that organ in the case of the bitch,* cat,† and fox.‡ Neither is it provided with any pigment-containing sac similar to that described by Bischoff in the placenta of *Lutra*,§ *Martes*,§ and *Mustela*.§

After removal of the placenta from the uterus, I attempted, by means of a pipe inserted into one of the umbilical arteries, to inject the foetal vessels. In consequence, however, of the parts having been previously immersed in spirit, these were contracted to such an extent as entirely to prevent the passage of the injecting fluid. To this absence of injection was due the difficulty which I experienced in obtaining a really satisfactory demonstration of the arrangement of the placental blood-vessels in general, and more particularly of the relation which the maternal vessels bear to those of the foetus. The elucidation of this point will only be accomplished by the examination of another injected specimen, but in view of the difficulty of obtaining such, I think it advisable meanwhile to communicate the results of my observations so far as they go.

When sections were made of the placenta, and the uterine margins of these were carefully examined under the higher powers of the micro-

* Von Baer, "Untersuchungen."

† Turner, "Lectures on the Comparative Anatomy of the Placenta," p. 71.

‡ "Sitzungsber. Akad. Wissensch.," München, 11 März, 1865, p. 218.

§ *Ibid.*, 13 Mai, 1865, p. 339.

scope, there was observable a total absence of anything like a clearly-defined limitary membrane on the papillary surface. Consequently, in sectional views, the papillæ were indistinctly isolated from one another, although as observed in surface views, the separation was clearly enough defined. Here and there, but extremely rarely, an isolated columnar epithelial cell was seen to be attached by its narrow end to the papillar surface. Whether the uterine surface of the organ had been invested by a continuous layer of these cells, or whether those seen had been detached from the uterine mucous membrane, I was unable to decide. In view, however, of the fact that the uterine mucous membrane was entirely devoid of such cells, the latter supposition appears the more probable. The trenches between the papillæ, as well as those between the latter and the surrounding ridges above described, were, to a considerable extent, filled with numerous shreds of decidua, as well as by a quantity of blood corpuscles which presented various forms, due doubtless to the action of the spirit in which the parts had been preserved. It was particularly observed, that no vessel of large size, and presenting the structure which I believe to be characteristic of those constituting the foetal portion of the placenta, extended beyond the uterine surface of the placenta. The marginal band of decidua reflexa presented the same structure as that of the mucous membrane of the impregnated uterine horn, to be afterwards described.

The foetal surface of the placenta was clearly defined in sectional views by the allantoic membrane. From this membrane numerous septa were given off at nearly regular intervals, and penetrated the substance of the placenta, so as to form, as it were, supports for the blood-vessels forming that organ. These placental septa could occasionally be traced as continuous structures nearly as far as the uterine surface of the placenta, but, for the most part, they disappeared before reaching the latter. In either case, they gradually became more delicate, and were finally lost to sight in the convolute of placental blood-vessels.

On proceeding to examine the blood-vessels composing the placenta, I found that these presented two distinct types of structure, according as I examined those which constituted the papillæ, or those which were met with in the circum-papillate ridges above described. In view of the facts which I am about to communicate, I regard the circum-papillate ridges as the torn margins of those processes of maternal tissue which interpenetrate the foetal villi, whilst the papillæ themselves are simply the free extremities of the foetal villi, which in the racoon, as in the bitch,* and cat,† reach the uterine surface of the placenta. The vessels met with in the maternal portion of the

* Turner, "Lectures on the Comparative Anatomy of the Placenta," p. 82.

† *Ibid.*, p. 79.

placenta resemble ordinary capillaries, whilst those which constitute the foetal portion present an altogether different appearance.

Foetal Portion of Placenta.—The foetal vessels constituted by far the larger portion of the placenta. Indeed, when sections of the placenta were examined, the entire mass of the organ was apparently composed of these. This I afterwards found was due to the fact that the processes of maternal tissue in the absence of injection, could not be traced to any great depth in the substance of the organ, and that the delicate capillaries with which they were furnished, were with difficulty distinguished amid the much larger vessels of the foetal portion of the placenta. The foetal vessels resembled neither arteries nor veins in the structure of their walls, and yet were of much larger calibre than ordinary capillaries. So far as I am aware, vessels presenting a similar character have only once been previously noticed, and that by Professor Turner in the *maternal* portion of the placenta of *Choloepus Hoffmanni*.^{*} With the observations of that anatomist, with regard to the structure of these vessels, my own, except in one or two points, almost entirely agree. When a portion of the placenta of racoon was teased out under the microscope, the vessels in question were seen for the most part to run parallel with one another, from the foetal to the uterine surface of the organ, and could be readily detached in the form of bundles from the cut edge of the placenta. When one of these bundles was farther manipulated, the separate vessels were observed for the most part to be of uniform diameter, although occasionally they presented well-defined enlargements. These in some instances occurred at regular intervals, and gave to the vessel a moniliform character. The vessels freely communicated with one another by means of transverse anastomosing branches of a similar diameter. These transverse anastomosing vessels were given off at somewhat irregular intervals, but for the most part they occurred at intervals which did not much exceed the diameter of the vessels themselves. In consequence of this arrangement, transverse-vertical and longitudinal-vertical sections of the placenta presented much the same appearance under the microscope. An examination of the foetal margin of these placental sections showed conclusively that at no spot did the vessels pass beyond this surface of the organ, but that, on the contrary, they invariably turned upon themselves, and re-entered the placenta, and that therefore, so far as their distribution in this direction was concerned, they were clearly confined to the substance of the placenta. With regard to their arrangement at the *uterine* or papillar surface of the placenta, as already observed, I could not distinguish any clearly-defined limitary membrane bounding their distribution in this direction. At the same time, I may observe, that although very numerous

* "Trans. Roy. Soc. Edin.," vol. xxvii, p. 79.

sections were made with the view of determining whether these vessels ever passed beyond the placental substance, in no single instance did I ever detect such an appearance as could lead me to believe that the vessels in question had been divided, and had, previous to the detachment of the placenta, passed from the latter into the wall of the uterus. Had such a passage taken place, it seems improbable, in view of the comparatively large size of these vessels, that the torn extremities of some at least of them would not have been recognised. The absence of any such appearance lends support to the view that the vessels under consideration really constituted and belonged to the *fœtal* portion of the placenta. Horizontal sections of the placenta; that is, sections made parallel to the surfaces of the organ, presented a different appearance. In these, by far the greater number of the vessels were seen to be either obliquely or transversely divided. This showed that these transverse anastomosing vessels above described were not for the most part united at right angles with the vertical trunks with which they inosculated, but that they pursued a more or less oblique course between the latter. Had they passed off at right angles with these, the appearance of the horizontal would have closely resembled the vertical sections, whereas, whilst the latter under the microscope presented a very similar appearance, the horizontal sections differed from them in respect of the much smaller number of longitudinally divided vessels which were visible.

When a portion of the placenta was teased out with needles under the microscope, these vessels were seen to be provided with extremely thick but apparently structureless walls. When immersed in solution of logwood, the latter were readily stained by that reagent. That they were composed of a form of elastic tissue was clearly shown by the singular immunity which they exhibited to the action of different reagents. Even when boiled in dilute hydrochloric acid, or digested for eighteen hours in solution of caustic potash, the walls of the vessels underwent apparently little change, and subsequently manifested their elastic nature by the resistance which they offered to the pressure of the covering glass. Professor Turner* observes that the walls of vessels, which, in other respects, present so close a resemblance to those under consideration, which he met with in the maternal portion of the placenta of *Cholæpus Hoffmanni*, possessed "no elastic tissue or muscular fibre cells." So far as the absence of muscular fibres is concerned, the placental vessels of *Procyon* agree with those of *Cholæpus*, but differ inasmuch as the wall, although apparently homogeneous under the microscope, is distinctly elastic in character. These vessels, in *Procyon*, were provided with a distinct endothelial lining which, although not always distinguishable, was in some vessels

* "Trans. Roy. Soc. Edin.," vol. xxvii, p. 80.

clearly enough defined. It consisted of closely applied, flattened endothelial scales, which at some places were of an oval form, whilst at others they were fusiform in character. As seen in transverse sections, the vessels, doubtless because of their strongly elastic walls, were observed to be uniformly open. They were in some cases completely, and in others partially filled by a granular looking material, which doubtless consisted of altered blood-corpuscles. In the latter case the vascular contents had shrunk away from the wall of the vessel, leaving a clear space between them and the endothelial lining of the tube. The vessels were imbedded in a matrix of faintly fibrillated connective tissue, which, however, was small in quantity, and in some places appeared to be altogether wanting. At these places, the vessels lay directly in contact with one another.

It is worthy of remark, that the colossal capillaries just described constituted by far the larger mass of the placenta, and that in this portion of the organ there was an almost complete absence of capillaries of the usual description, these being confined to the circum-papillate ridges, and their prolongations, which I regard as constituting the *maternal* portion of the organ.

Having now described the histological appearances of what I regard as the *fœtal* portion of the placenta, I pass to the consideration of that of the *maternal* part. I have already shown that each of the papillæ met with on the uterine surface of the placenta was surrounded by a well-defined wall of tissue which bounded a space, in the centre of which the papilla was situated. The papillæ consisted exclusively of a mass of colossal capillaries, together with a small amount of inter-vascular connective tissue matrix. An examination of the circum-papillate ridges with a simple lens showed that these were merely the free edges of a number of elongated processes which dipped into the substance of the placenta. With a little care these ridges, together with their intra-placental prolongations, could readily be drawn out from the substance of the placenta and submitted to microscopic examination. After being teased out and placed under the microscope with a magnifying power of 440 diameters, these processes were seen to present exactly the same structure as the mucous membrane of the impregnated horn of the uterus, of which, without doubt, they were prolongations. They consisted of a slightly fibrillar connective tissue largely intermingled with clear granular cells resembling leucocytes, together with numerous spindle-shaped connective tissue corpuscles. Moreover, in certain preparations which I was fortunate enough to procure by simply drawing out the processes in question from the placental substance, I was able to observe that the surfaces of the latter were covered with a layer of columnar epithelial cells,

which, at some parts, formed a continuous investment to the processes; whilst, at others, the epithelium having, to some extent, been abraded, although a continuous covering was absent, these cells, isolated, or in groups of various sizes, still adhered to the surface of the process under examination. These cells closely resembled those lining the alimentary canal, and were provided with a well-defined nucleus of a round or oval form. I have little doubt that in the recent state these cells had formed a *complete* investment to the maternal processes. It was particularly remarked that in none of these processes was there any trace of the colossal capillaries above described, but that their blood-vessels consisted exclusively of capillaries of the ordinary description, and exactly resembled those met with in the uterine mucous membrane.

Professor Turner has already described, in the placenta of *Cholæpus*, two sets of vessels which almost exactly correspond to those above referred to *Procyon*. His observations, however, were rendered more perfect than my own by the fact that he was able to inject the placenta both from the foetal and maternal vessels. From the completeness of this injection he was enabled to decide that the *colossal* capillary system constituted the *maternal* portion of the placenta, whilst the capillaries which presented the usual structure appertained to the *foetal* portion. I have, consequently, endeavoured to reconcile my own observations with those of Professor Turner, but in vain. Of a direct connexion between the *colossal* capillary system and the foetal umbilical vessels in *Procyon*, I was, of course, in the absence of injection, unable to convince myself. But, bearing in mind the facts (1) that in no single instance did I observe any appearance of the passage of a colossal capillary beyond the placenta into the wall of the uterus; and (2) the exact correspondence in structure of the circum-papillate ridges with that of the uterine mucous membrane; and (3) the probable continuity of these processes with the mucous membrane of the uterus; I can (subject, however, to future correction) see no escape from the conclusion that in *Procyon* the colossal capillaries belong to the *foetal*, whilst the ordinary capillaries constitute the vascular portion of the *maternal* placenta.

Having now described the minute anatomy of the placenta, I pass to that of the uterine mucous membrane. Having made sections of the wall of the left or unimpregnated uterine horn, and subjected these to the staining action of logwood, with the aid of the microscope the presence of numerous uterine glands could be readily recognised. These glands were very unequally distributed in the mucous membrane. At some places they appeared to form patches, and were so closely packed that the interval separating any two of them did not exceed half the diameter of a gland tube, whilst at others the individual glands were separated by a much

larger interval. They occurred indifferently upon the transverse mucous rugæ and upon the intermediate depressions. The glands themselves corresponded in length to the thickness of the mucous membrane, their blind dilated ends closely approaching but never actually penetrating the sub-mucous coat, whilst their free extremities opened upon the surface of the mucous membrane. The gland tubes were extremely tortuous, so much so that, in some instances, their regularly spiral course reminded one of the epidermic segment of the duct of a sudoriparous gland. In some cases, the tubes terminated in a single dilated and somewhat acinous extremity, whilst in others two or even three of these dilated acini could be seen to terminate in a common tube. The character of the epithelium lining these glands could not, unfortunately, be made out, but it seems probable that it does not differ essentially from that met with in the uterine glands of other mammals. The epithelium covering the surface of the mucous membrane of the unimpregnated horn had entirely disappeared, and, therefore, its character could not be determined.

The mucous membrane of the impregnated horn was quite entire. It differed from that of the barren horn in the absence of the well-defined transverse rugæ already described. The mucous lining of this horn was much thinner than that of the opposite side, and appeared as if it had been mechanically stretched by the growth of the contained fœtus. When a portion was placed under the microscope, it was seen to differ from that of the barren horn in respect of its much softer and more succulent character. This was due to the presence of large numbers of leucocytes, as well as of spindle-shaped connective tissue cells in various stages of growth. In the barren horn, the latter were present as formed connective tissue, and, consequently, lent to the mucous membrane a denser, tougher, and more fibrous consistence. In the mucous membrane of the non-placental area of the gravid horn uterine glands were but rarely distinguishable and then only in a fragmental form. Here and there minute fragments of gland tubes were observed, but, in no case, did I recognise a *perfect* gland similar to those met with in the opposite horn. In the mucous membrane of the placental site not a trace of a uterine gland could be recognised, the glands in this area having apparently atrophied and entirely disappeared. As regards the epithelial lining of the gravid horn, no certain information could be obtained, as the mucous membrane had been almost entirely denuded of epithelial cells. At the same time, the appearance of an occasional epithelial cell, columnar in character, and attached to the uterine surface of the placenta, renders it probable that previous to detachment of that organ the uterine mucous membrane had been provided with a layer of columnar epithelial cells, similar to that observed by

numerous authors in other species of mammals. The fact, moreover, that the intra-placental prolongations of maternal mucous membrane were invested by such a layer of cells lends additional support to this opinion.

I have already remarked that, with the exception of its epithelial layer, the mucous membrane of the gravid horn of the uterus, subsequent to detachment of the placenta, was quite entire, and that the uterine surface of the placenta was not invested by a complete layer of decidua serotina, such as is met with in the shed placenta of the cat.* In *Procyon*, therefore, the intra-placental prolongations of maternal mucous membrane, together with the epithelium, are alone deciduous, the mucous membrane of the uterus remaining adherent after detachment of the placenta.

Comparison of the Placentation of Procyon with that of other Carnivores.

From the particulars above detailed, it will be seen that *Procyon* agrees with the other carnivorous mammals, with the placentation of which we are acquainted, in respect of the annular or zonary form of its placenta. This form of placenta, and this alone, has been met with in the various members of the group Carnivora, the placentation of which has hitherto been examined. In the majority of these the placenta forms a complete zone, and presents no trace of the placental gap which, in *Procyon*, occurs at that part of the placental band which lies in relation to the dorsum of the embryo. The gap in question has, however, been observed in the placenta of a few carnivores. So far as recorded observations go, while failing to recognise the presence of this gap in the placenta of any *digitigrade*, or pinniped Carnivore, they have affirmed its presence in the placenta of every member of the *plantigrade* section, the placentation of which has been hitherto examined. The latter group includes the genera *Martes*, *Mustela*, and *Lutra*, in the members of each of which a placental gap has been observed. With these, therefore, *Procyon* agrees more closely as regards its placentation than with any member of either the *digitigrade* or pinniped groups, in the placenta of none of which does the gap in question occur. If Bischoff's explanation of the formation of this gap be correct, it would appear that, in the *plantigrade* Carnivora, the closure of the true, and the consequent separation of this from the false amnion takes place at a relatively later date in the latter than in either the *digitigrade* or pinniped Carnivora.

But, whilst the placenta of *Procyon* differs, in this respect, from that of the members of the *digitigrade* and pinniped groups of Carnivora, it agrees with them in its truly deciduous character, as exempli-

* Eschricht, "De Organis," pp. 14, 18; and Turner, "Lectures on the Comparative Anatomy of the Placenta," p. 80.

fied in the case of the bitch, cat, fox, and seal. The interlocking of the intra-placental processes of maternal mucous membrane with the foetal chorionic villi, and the separation of both from the uterine wall, have been already described; and although the processes of maternal tissue could without difficulty be withdrawn from the interstices of the chorionic villi, it must be borne in mind that, at the time of separation of the placenta, the full period of gestation had not been completed, and that, in all probability, had such been the case the union between the foetal and maternal portions of the placenta would have been more intimate than in the specimen examined. Although, owing to the absence of injection, the precise form of the chorionic villi and the mode of interlocking of these with the maternal processes could not be ascertained, there seems little reason to doubt that their arrangement presented a close resemblance to that described by Professor Turner in the placenta of the bitch, cat, and seal. The structure of the maternal portion of the placenta of *Procyon*, moreover, agrees in all respects with that of the animals just named, consisting as it does of processes of the mucous membrane of the uterus which are richly supplied with capillaries presenting the same structure as those of the uterine mucous membrane itself. A farther resemblance between the maternal processes of the placenta of *Procyon* and those of the other mammals mentioned is to be found in the presence, in all, of a well-defined layer of columnar epithelial cells investing these processes.

With regard to the appearance presented by the uterine surface of the placenta, *Procyon* agrees rather with *Canis* than with *Felis*. The very regular arrangement of the uterine extremities of the foetal villi, surrounded as they are by the circum-papillate ridges of maternal tissue, is certainly peculiar to the racoon. At the same time, an examination of the uterine surface of the placenta of the bitch, at nearly full time, convinced me that the difference in this respect between the placenta of *Procyon* and that of *Canis* is one of degree rather than of kind. In the latter, although the arrangement of these two constituents on the uterine surface of the placenta is by no means so regular as that met with in the racoon, yet indications of it were plainly observable. In the bitch, as observed by Turner,* and this observation I can confirm, the chorionic villi reach the uterine surface of the placenta much as in *Procyon*. Surrounding them are numerous ridges of maternal tissue which, although by no means presenting the regular honeycomb appearance met with in the racoon, nevertheless, at places, closely resemble it. In the bitch, these ridges for the most part enclose irregular polygonal spaces, in the centre of each of which lies the uterine extremity of a foetal villus, whereas in *Procyon* these spaces present a regular honeycomb appearance.

* "Lectures on the Comparative Anatomy of the Placenta," p. 82.

But farther, a comparison of the placenta of the racoon with that of the bitch and cat shows that in one important particular *Procyon* agrees with *Canis* rather than with *Felis*. As has long been known, the uterine surface of the placenta of the cat, after being detached from the uterus, is covered with a distinct and continuous layer of decidua serotina, whereas, in the bitch, as shown by Professor Rolleston,* this is not the case. In this animal, the deciduous portion of maternal tissue consists simply of the intra-placental processes which are detached along with the placenta, whilst the uterine mucous membrane is not deciduous, but remains adherent to the wall of the womb. Such is also the case in *Procyon*, and consequently in it, as in the bitch (and apparently also in the fox),† the uterine mucous membrane forms a continuous lining to the wall of the uterus, after detachment of the placenta; whereas, in the cat, according to Turner,‡ subsequent to the separation of that organ, only the deeper part of the sub-epithelial connective tissue of the uterine mucous membrane remains adherent. Whether, in *Procyon*, the epithelium of the uterine mucous membrane is normally detached along with the placenta, unfortunately I could not determine.

Professor Turner has observed that in the mucous membrane of the placental area of the sloths§ and seals,|| the uterine glands appear to undergo a retrograde metamorphosis, and to become of little functional importance during the latter period of pregnancy. The same remark holds good of the uterine mucous membrane of *Procyon* in which, as already shown, the uterine glands, although well developed, and present in large numbers in the unimpregnated horn, are with difficulty recognisable in the non-placental area of the gravid horn, and then only in a fragmental form, whilst, in the placental area, they have entirely disappeared. It would appear, therefore, that, at least in the Carnivora, the uterine glands are functionally inactive subsequent to the period when the placenta has been fully developed.

Whilst, however, the placenta of racoon agrees thus far with that of other Carnivora, it differs materially in respect of the structure of the blood-vessels which constitute by far the larger portion of that organ. As already observed, Professor Turner met with similar vessels in the placenta of *Cholæpus*. In that animal, however, the placenta is dome or bell-shaped and not annular in character. So far as I can ascertain, *Cholæpus* and *Procyon* are the only genera in which these vessels have been hitherto discovered. In every particular, except the elastic nature of their walls, the foetal vessels of *Procyon* agree with the

* "Trans. Zool. Soc.," v, 1863.

† Turner, "Lectures on the Comparative Anatomy of the Placenta," p. 85.

‡ *Ibid.*, p. 80.

§ "Trans. Roy. Soc. Edin.," vol. xxvii, p. 100.

|| *Ibid.*, xxvii, p. 300.

maternal vessels of *Cholæpus*. I have already referred to the difficulty of reconciling two sets of observations, in accordance with one of which, these vessels appertain exclusively to the fœtus (*Procyon*), whilst according to the other they belong as exclusively to the mother (*Cholæpus*). This difficulty must remain until the placenta of *Procyon* has been re-examined after successful injection of both the fœtal and maternal vessels. But, even granting that future research may allot the colossal capillary system of *Procyon* to the mother and the ordinary capillary system of its placenta to the fœtus, the mere presence of vessels of so peculiar and identical character in the placenta of *Procyon lotor* and *Cholæpus Hoffmanni*—animals between which there is not a single additional point of structural resemblance,—and the absence of such from the placenta of every other Carnivore which has hitherto been accurately examined, appears to me to afford only one additional proof to the many hitherto adduced of the futility of any attempt to base a sound classification of the Mammalia upon the form and structure of the placenta. There does not, indeed, appear to be any reason why the placenta, either in respect of form, structure, or both, should agree in animals which are closely allied, or differ in species, which upon other grounds we regard as widely separated from one another. The researches of Turner and others have made us aware that, reduced to its essentials, the connexion between the mother and the child is the same in all mammals, that is, it consists of an intimate contact of the fœtal and maternal blood-vessels. This, however, is simply a physiological necessity, the accomplishment of which may be brought about in many different ways. *A priori*, therefore, the particular arrangement by means of which this is accomplished is hardly likely to be constant in, or confined to one group of mammals, or such as will result in the formation of an organ which structurally, or morphologically, is likely to be of any value in affording a basis of classification. The zonary form of placenta is met with in such widely separated groups as the Carnivora, Hyracoidea, and Proboscidea, whilst the diffused placenta is common to the Suidæ, Delphinidæ, and Equidæ, and any classification based upon the possession by forms (in other respects so widely separate) of a single organ, the placenta, simply because it possesses the same form in all, must necessarily lead to error in classification, if by classification we understand the grouping together of animals in accordance with their affinities, that is, in accordance with their entire structural organisation. Similarly, to attempt to classify the Mammalia in accordance with the structure of the placenta would lead to the association of forms which in other respects have nothing in common. The Suidæ and Lemurina, in respect of the structure and arrangement of the vessels composing this organ closely resemble one another, as do also *Procyon* and *Cholæpus* in the possession of vessels which present structural

characteristics not hitherto met with in the placenta of any other mammal. And yet, to associate the members of either of these groups would, taking into consideration the wide divergence which they otherwise structurally possess, be as rational as to group together the elephant and the spotted hyæna, simply on account of the possession by the female of both of these animals of a urogenital canal, presenting peculiar features not met with in that of any other mammal. A natural classification cannot possibly be based upon the form or structure of any one organ in any group of animals, but must take into consideration the various modifications of every organ of the animal body; and more especially of those proved by research to be of great morphological, although not necessarily of equal physiological, significance. As additional evidence of the slight value to be attached to the form or structure of temporary uterine and foetal structures as affording a basis of classification, I may refer to the fact that whilst the structure of *Procyon* is such that it has very properly led naturalists to associate that genus with the arctoid group of Carnivores, yet the foetus of *Procyon lotor* is provided with a supernumerary cuticular investment, or epitrichium, of which, according to the observations of Welcker,* the foetus of *Ursus* presents not a trace. Of the structure of the bear's placenta we at present know nothing, but when it comes to be examined, in view of the inconstancy of foetal structures in the members of one and the same group of mammals, there seems to be little ground to anticipate that vessels presenting the peculiarities above described in the placenta of *Procyon*, will be found to be any more characteristic of the arctoid group, as a whole, than the epitrichium has proved to be.

The foetal membranes of *Procyon* agree for the most part with those of other Carnivora. The absence, however, in the former of an umbilical vesicle in the advanced condition of the embryo, is remarkable, and appears to separate *Procyon* from every other member of the carnivorous group of mammals. The chorion differs in no respect from that of other Carnivora. In *Procyon*, as in *Canis*, *Felis*, and *Phoca*, the placental vessels extend beyond the placental into the non-placental area of this membrane. The allantois presents a similar arrangement in all Carnivora. With regard to the amnion, *Procyon* agrees with the members of the plantigrade section of Carnivora at the same time that it differs from those of the digitigrade and pinniped sections in the late closure of the amniotic sac, in the close attachment of that sac at one spot to the foetal surface of the placenta, and (adopting Bischoff's view)† in the consequent deficiency of placental substance at that spot.

* "Abhandl. der Naturf. Gesellsch.," Halle, Band ix, p. 39.

† "Sitzungsber. der Akad. Wissensch.," München, 1865, p. 219.

In conclusion, it may be as well to summarise the observations contained in the foregoing pages. These show:—

1. That *Procyon* agrees with *all* the other Carnivora in which that organ has been hitherto examined in the possession of a *zonary* or *annular* placenta.

2. That similarly *Procyon* agrees with all in the mode of interlocking of the foetal and maternal portions of the placenta, and in the consequent deciduate character of that organ.

3. That *Procyon* agrees with the members of the *plantigrade* section, at the same time that it differs from those composing both the *digitigrade* and *pinniped* sections of the Carnivora, inasmuch as at one spot the placenta presents a gap or deficiency, at which spot the placental structure is imperfect.

4. That *Procyon* agrees with *Canis* at the same time that it differs from *Felis*, in the absence of a continuous layer of *decidua serotina* from the uterine surface of the detached placenta.

5. That *Procyon* differs from every other Carnivore, the placenta of which has been minutely examined, in the possession of placental vessels possessed of a structure hitherto only met with in the placenta of *Cholæpus Hoffmanni* among the Edentates.

6. That *Procyon* differs from every other Carnivore, the foetus of which has been hitherto examined, in the non-possession of an umbilical vesicle.

7. That *Procyon* differs from all Carnivora of which the young have been hitherto examined, inasmuch as the foetus is provided with a supernumerary cuticle or *epitrichium*, a structure which has only been met with in the young of certain members of other mammalian groups.

EXPLANATION OF PLATES.

I have to acknowledge, with thanks, the kindness of my friend, Mr. Alfred Young, in drawing the accompanying excellent illustrations of the microscopic anatomy of the placenta and uterine mucous membrane.

PLATE 3.

Figure 1. Exterior of the female organs of *Procyon lotor* in the gravid state, two-thirds natural size. R.C. Right cornu uteri in which the foetus was lodged. L.C. Left cornu uteri. O.O. Ovary encircled by the Fallopian tube. L.D. L.D. Ligamentum diaphragmaticum uteri. L.T. L.T. Ligamentum teres uteri. L.L. Ligamentum latum uteri. B. Bladder.

Figure 2. The foetal membranes after removal from the uterus. As stated in the text, the membranes were ruptured when the specimen came into my hands. Their appearance, after I had divided the placental belt and removed the foetus, is faithfully reproduced in this figure. A. Amnion. C.C.C. Chorion. P.P. Placenta. The umbilical vessels are seen ramifying on the foetal surface of the latter.

Figure 3. The placenta, showing the central gap which corresponds to the attachment of the amnion, as shown in fig. 2.

Figure 4. The foetus with its epitrichial investment. The latter has been slit open along the ventral surface of the animal.

PLATE 4.

Figure 5. Interior of the gravid uterus of *Procyon lotor*, two-thirds natural size. In the right cornu uteri the foetus is shown enveloped by the chorionic membrane and surrounded by an annular or zonary placenta. The left cornu uteri is opened to show the transversely-arranged mucous folds. Between the cornua is the septum uteri. o.v. Os uteri, provided with a valve-like fold of mucous membrane, which separates the uterus from v. the vagina. u.g.c. Urogenital canal laid open. A bristle is passed into the urethra. Other letters as in fig. I, Plate 3.

Figure 6. Left cornu uteri, natural size, seen from above. The drawing shows the abdominal opening of the Fallopian tube and the relations of that tube to the ovary. o. Ovary. c.u. Cornu uteri. l.d. Ligamentum diaphragmaticum uteri. f.t. Fallopian tube.

Figure 7. Surface view of portion of the mucous membrane from the placental site of the gravid horn, slightly magnified.

Figure 8. Section of wall of barren horn of uterus, to show the uterine glands. Magnified 55 diameters.

PLATE 5.

Figure 9. View of uterine surface of the detached placenta, showing the honeycomb appearance, slightly magnified.

Figure 10. Horizontal section (*i.e.*, the line of section was parallel to the surface of the organ) of the placenta, showing the colossal capillaries, for the most part divided *transversely*, magnified 235 diameters.

Figure 11. Portion of the placental substance, teased out after being submitted to the action of dilute sulphuric acid. The figure shows the structure of the colossal capillaries, their endothelial lining, and the mode of anastomosis between them, magnified 235 diameters.

PLATE 6.

Figure 12. Longitudinal vertical section (*i.e.*, the line of section was at right angles to the surface of the organ) of the placenta, showing the colossal capillaries, for the most part divided *longitudinally*, magnified 235 diameters.

Figure 13. Transverse vertical section of the placenta, showing the colossal capillaries with the intervaseular matrix. The capillaries are for the most part divided *longitudinally*, magnified 235 diameters.

Fig 1.

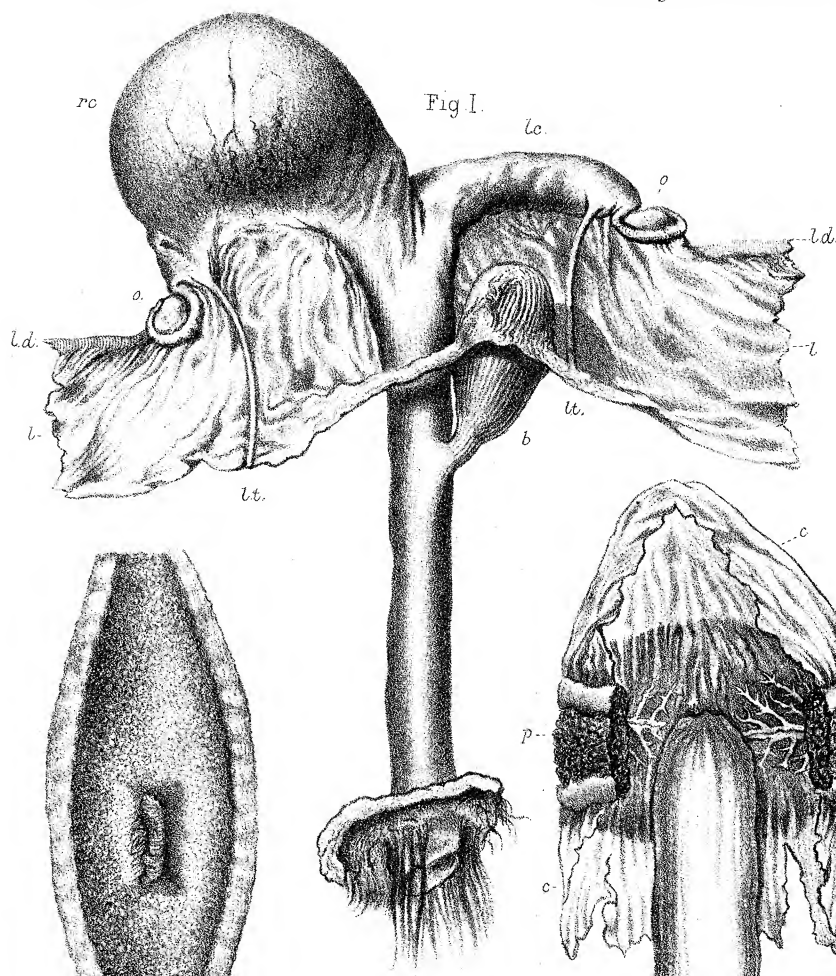


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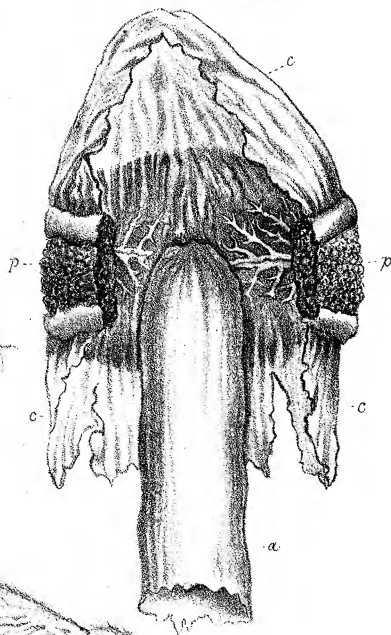


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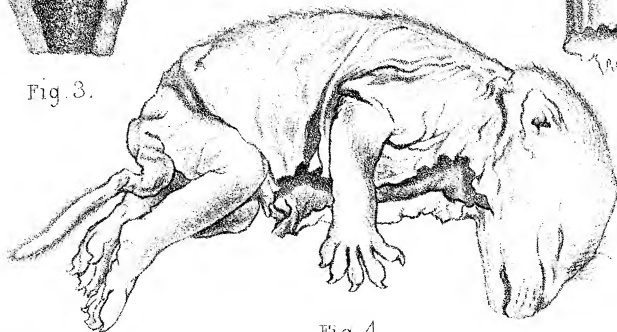


Fig 4.

Fig. 5.

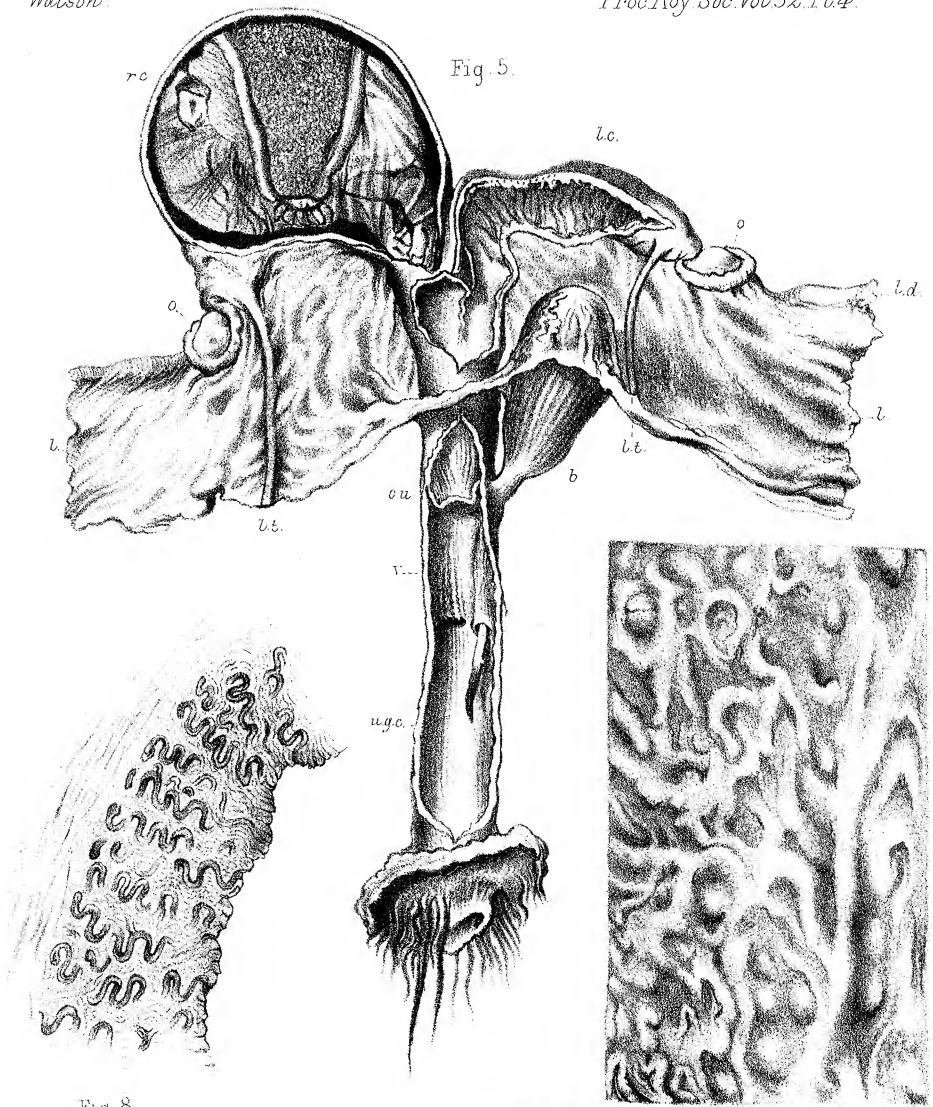


Fig. 8.

Fig. 7.

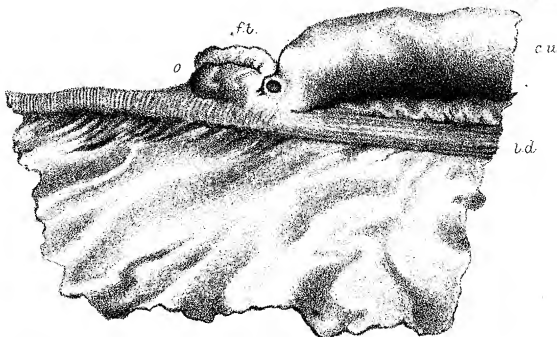


Fig. 6.

Fig 10.

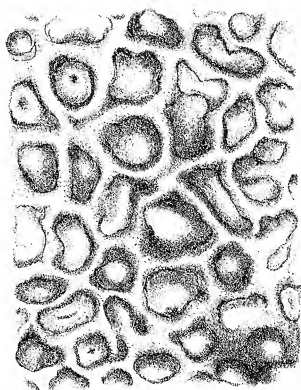
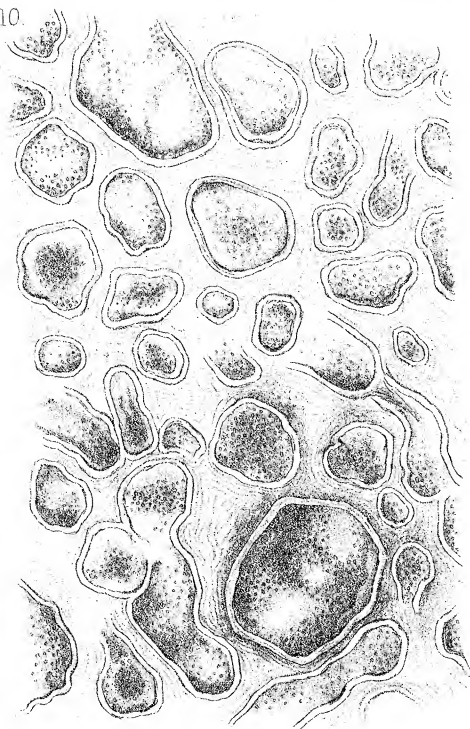


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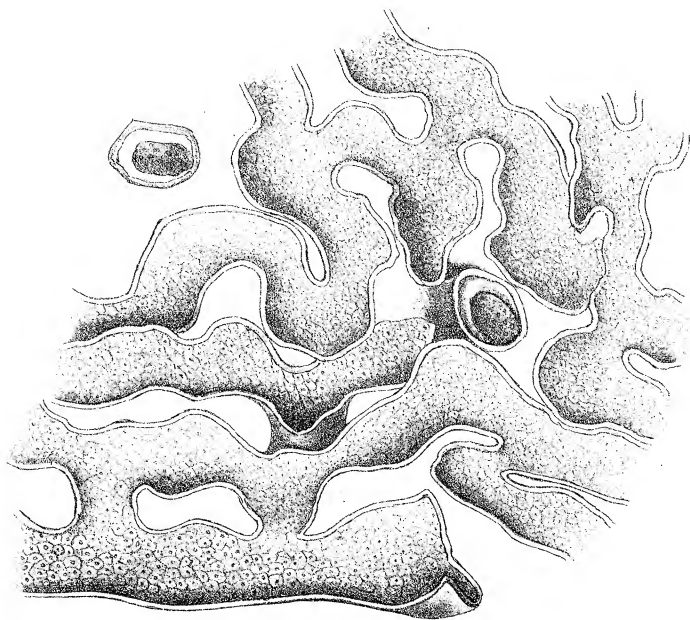


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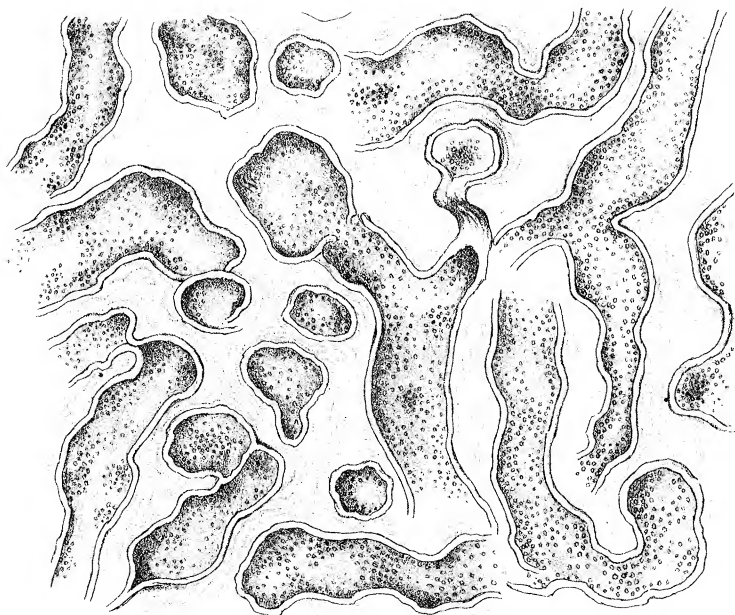


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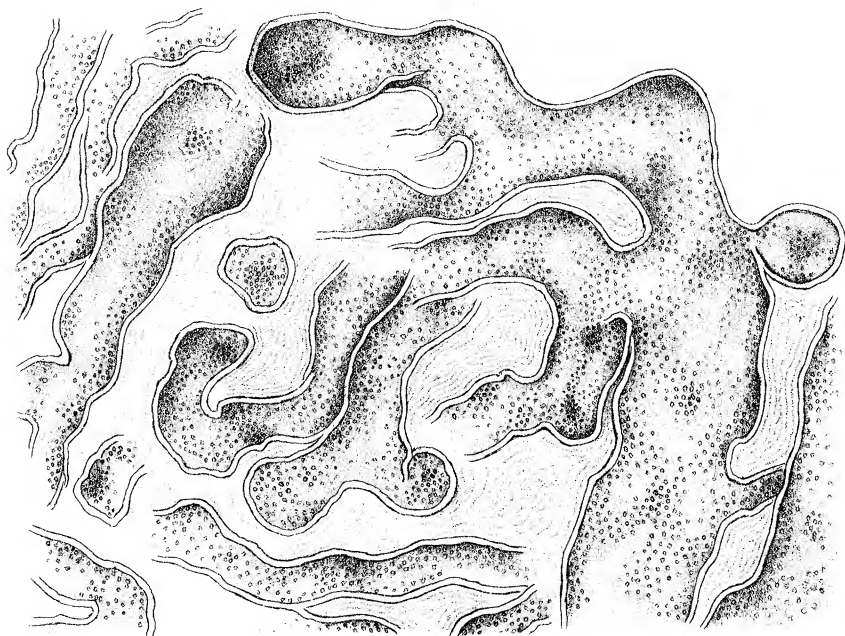


Fig. 13.

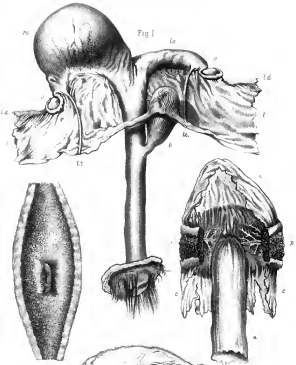


Fig 1

Fig 3

Fig 2

Fig 5

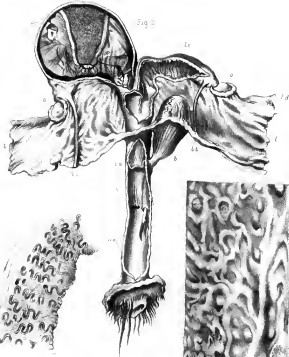


Fig 7



Fig 6

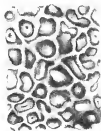


Fig. 2



Fig. 3

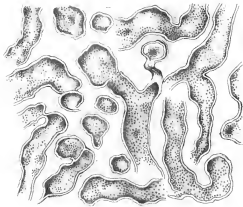


Fig. 7

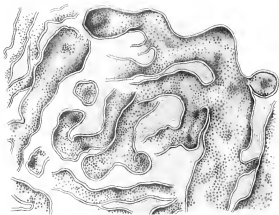


Fig. 8